SMALL _ARTIFACTS LAB;

Rapid-Prototype Robot Competition

Abstract

In this project, you are going to design, build, and prototype a working bridge-crossing robot. The robot design is under given constraint and will fulfill given tasks at the competition. Please read this document **THOROUGHLY** before starting on the project!!!

Design Constraints and Requirements

The basic function of your robot is to move along a "bridge" (Figure 1). The bridge is about 1 meter long and is wrapped with a layer of soft foam. You will try to move your robot from the start — one end of the tube to the other end, then come back. The bridge is installed in Sandbox and you are free to test your design any time before the competition day.

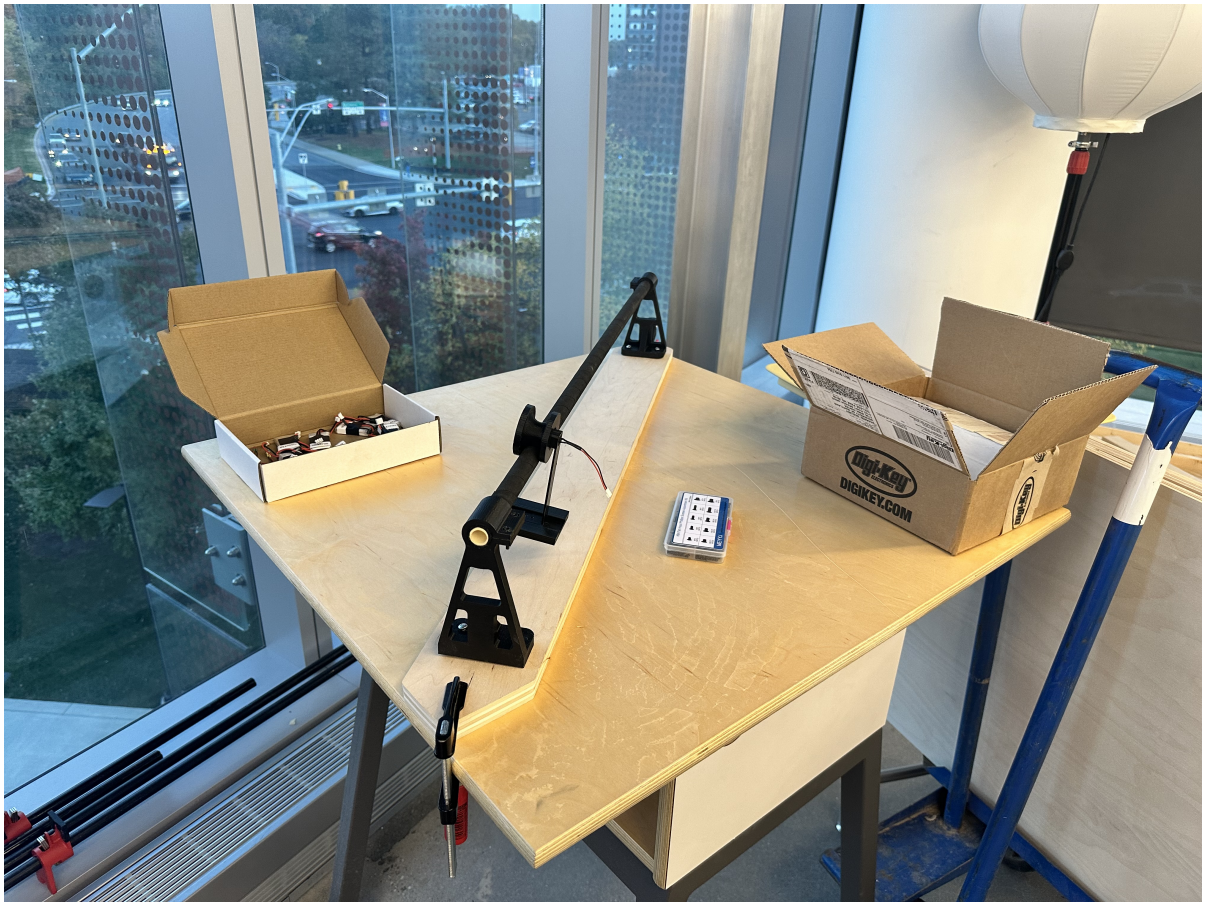

Figure 1: Bridge setup in Sandbox.

For this project, there is no dedicated design you should follow. In other words, as a designer and prototyper, you are free to design the bot and its climbing mechanism however you want. Although, as there is no project without limitations on resources, here are **four design requirements** that you should follow:

1. Only one ESP32, one motor driver, and one gear motor are allowed in your robot design. Figure 2 shows the motor driver and the gear motor. Alternatively, you are allowed to substitute the gear motor with the servo motor that is provided in your kit. If you decide to use the servo motor, you are not allowed to use the gear motor, hence no motor driver is needed. You are allowed to use other non-actuation components in your design, e.g. IMU. If you are not sure whether certain parts can be used for your project, consult your instructor and TA.

2. Your robot will be powered via either the usb cable provided, or a 7.4v 250-350 mah Li-Po battery. Note that there are advantages and disadvantages both ways, please read the "Hint" section for more information.

3. Your robot has to be controlled by a laptop via keyboard. There should be at least 3 commands functional: move left, move right and stop. You can choose to send the command either via Bluetooth or serial (closely related to how do you want to power your robot). You can also implement WIFI connection between your laptop and your esp32, however, since WIFI drains the battery really quickly and router won't be provided at the competition, we don't recommend WIFI as your first choice. But if you do decide on using WIFI, please make sure you can accommodate your robot with proper power source and connection at the competition.

4. You should design your robot self-contained. That is, your robot should hold all the electronics, except the usb cable if you decide to use one. Any Free hanging/moving motor, battery, breakout board, bread board, etc. will lead to points off. Any glue or tape will also lead to points off. We will provide a set of M2 bolts and nuts to work with, you are welcome to introduce any hardware you have access to into your assembly. Note that the batteries are going to be for shared use, so you should design your battery holder easy to access and easy to get battery in and out.

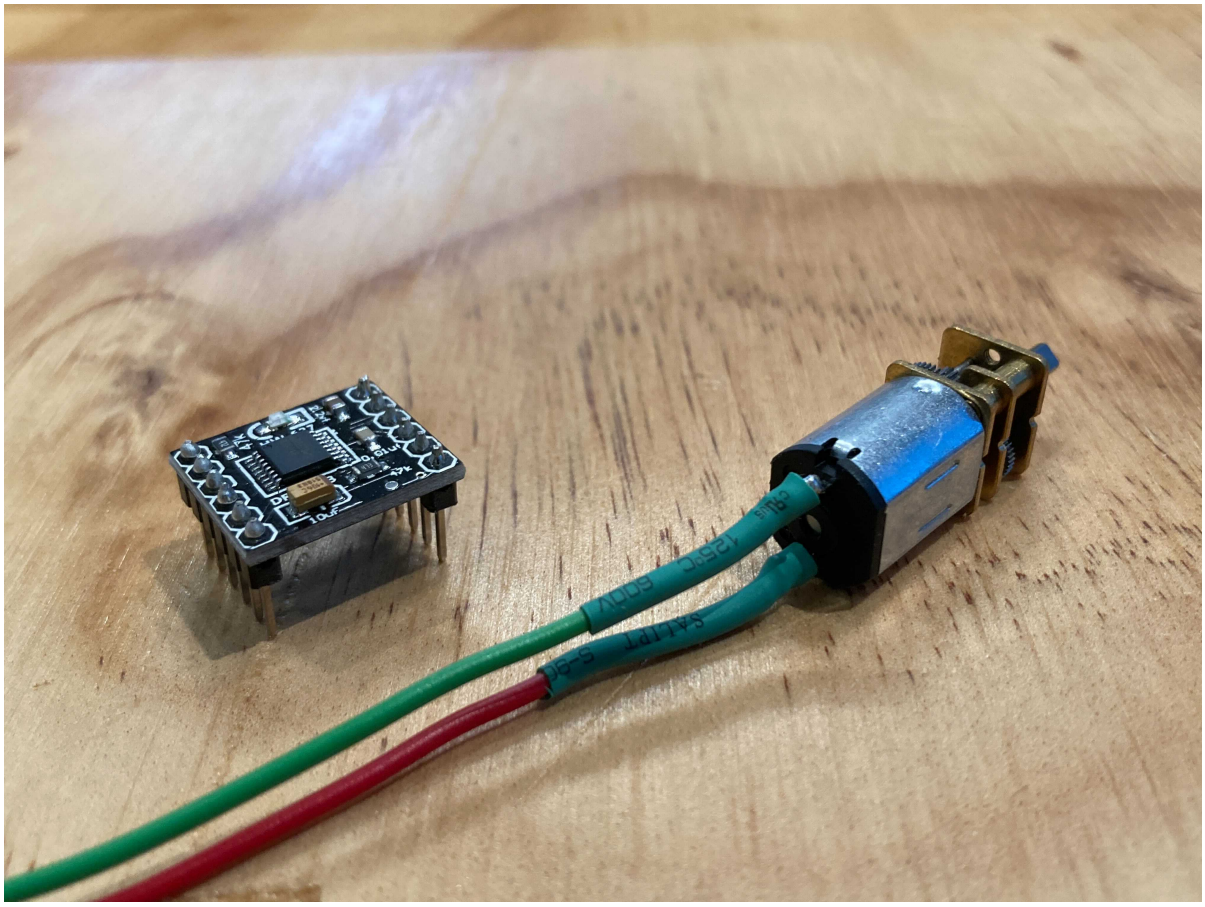

Figure 2: We will provide each group one gearmotor and one DRV8833 motor driver.

Competition

At the competition/demo day (Wed Nov 15), we will test run all robots. Your robot will start at one side of the bridge, cross the bridge, stop, and come back. There are markers that indicates the start and finish line on both sides of the bridge. Each group will be given two chances (On the mark of robot crossing the start line). Accomplishing this task partially will be granted partial grade.

You will aim at finishing the "run" at a fast speed. We will time each run, and the top 3 groups with the "fastest lap" will be granted extra credit (worth 5% of the total points if this project).

The instructor and TA will also pick 2 of the most outstanding mechanism design and award bonus credit (worth 10% of the total points of this project) to the two groups.

Team

Unlike the weekly assignment, in this robot design project you will pair up with another classmate and work together on the design. We have opened a number of groups on ELMS. You can sign up yourself to one of the groups like how we did for the semester-long project.

Logistics

To accommodate this competition and your robot development, Sandbox is generously offering a spot for you to test your prototypes along the way. We will use the same setup to hold the competition. Please make sure all the items at the "development center" won't leave sandbox.

The setup includes:

1. The "bridge" your robot will be crossing.
2. 5 of 7.4v 250-300mah Li-Po batteries, for sharing (Figure 3).

These batteries have been charged to full. If you find a battery run out, bring it down to 0102 and we will charge it for you.

Figure 3: Batteries can be used for testing.

The prototyping workflow of Assignment 2 (radar fixture) applies in this project. You can use any 3D printers (please make sure you finished the training for any machines you are using, and ask for help if you are not sure what to do) in the Sandbox for prototyping, we will buy filament directly for Sandbox as compensation. Please follow their rules when it comes to printer management.

Hint

- Motor Driver. The motor driver detail can be seen in DRV8833 data sheet, this is used to drive the DC motor. In all you need to connect "VC" and "GND" of the motor driver pins to the "5V"and "GND" pins on your esp32 correspondingly. (incorrect connection will fry the chip!!!) Your control signal should come out from any PWM GPIO pins in to "IN3" and "IN4", and your motor should be connected to "OUT3" and "OUT4".
- Battery. The battery should **NEVER BE SHORTED**. This could happen when you are connection components together, so make sure you pay extra attention when doing it. Please do not use batteries that is not provided, unless you are knowledgeable about and sure about what is going to happen (We don't have extra for a lot of the components if you fry them). The battery positive **should be connected to the "5V" pin and the negative should be connected to the "GND"pin** on your esp32.
- Robot Design Degree of Freedom. Since you are only allowed to use 1 motor/servo, so that is going to be the only source of kinematic energy. Feel free to come up with any kinematic chain to fulfill the task, but this can also be as simple as one rotational wheel.
- Center of Gravity. During the testing you might find your robot not willing to stay on the bridge because it is "top-heavy". You should try to put as much weight below the bridge to make stable movement.

Delivery

There are two deliverable items besides the competition. The deliverable files will take up 50% of the grade in this project, and the competition will be used to grade the rest 50%. The files we need from you are listed below:

- Upload your Arduino code. (Name it following the convention "group_GROUPNUMBER.ino", for example "group_1.ino", incorrect naming will not be graded)
- Your Fusion 360 file(s) for your robot assembly. This will be a ".f3d" file or —.f3z" file following the same naming convention as above (except for the different file extension name). Please try to upload your file to a new repository to validate that your models will load correctly. The file should contain all the 3D models you make and the DC motor/servo motor model. Bread board and battery is not required to be presented in this file.

*Please zip all files into a ".zip" file and name it in the following format: "group_GROUPNUMBER.zip". The file should be uploaded to ELMS under "robot competition".

Due Date

Wed Nov 15th, 3:30 PM EST

Last Modified Date: Oct 16th, 2023